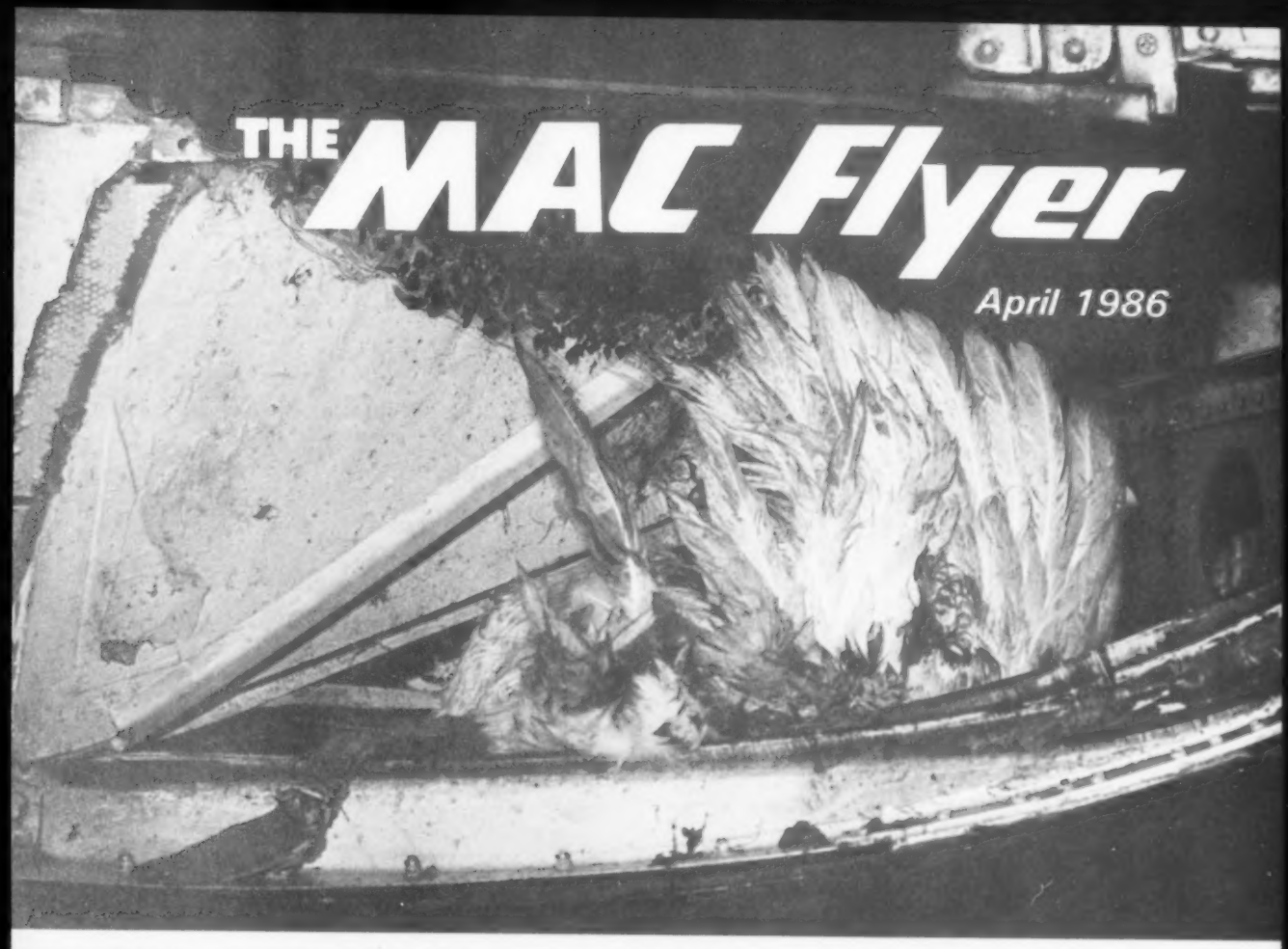
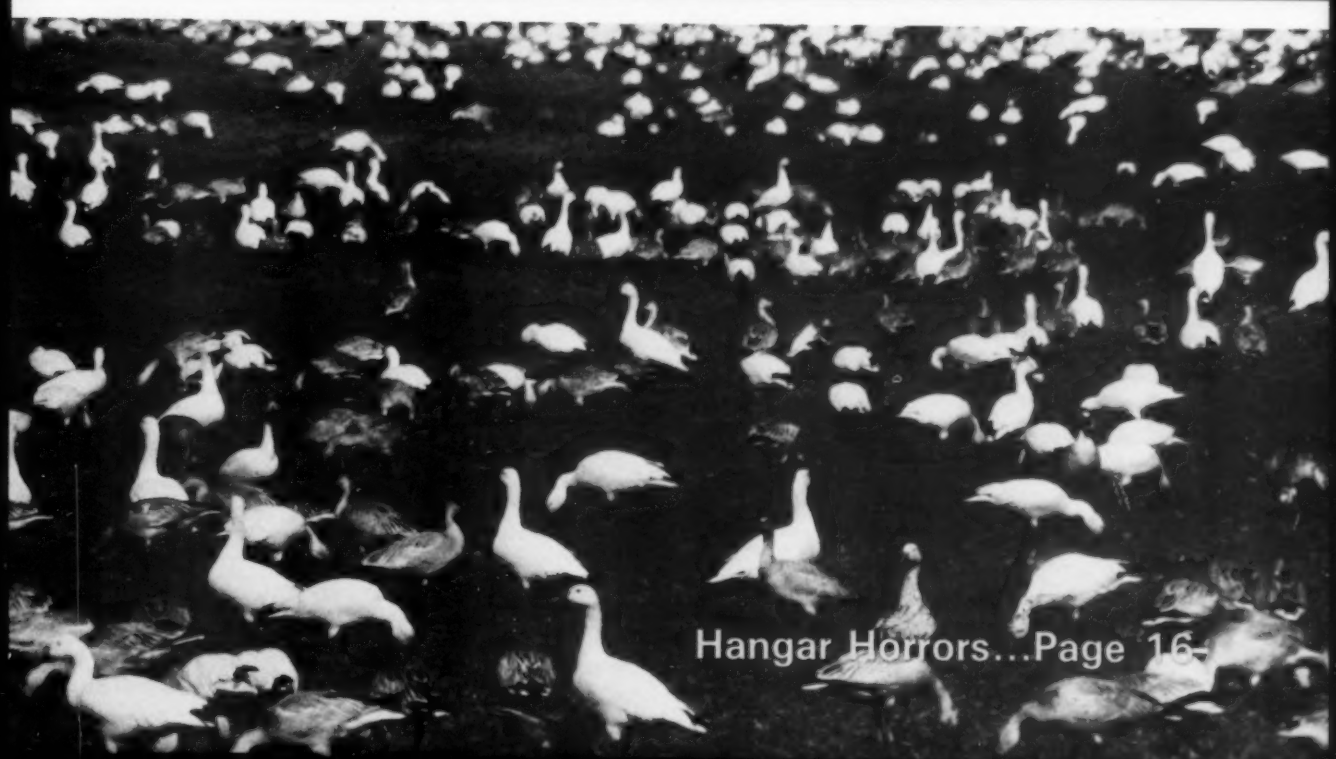
THE MAC Flyer

April 1986





Hangar Horrors...Page 16

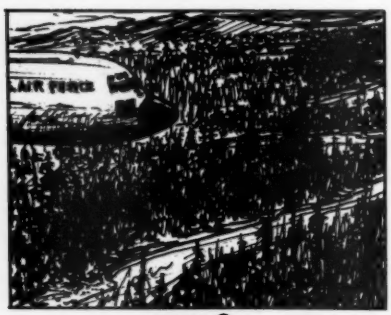
THE MAC Flyer

For Greater Safety in MAC Air Operations

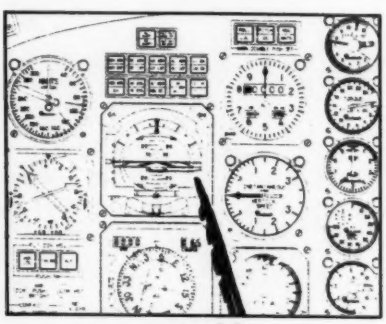
April 1986 | MACRP 127-5 | VOL XXXIII NO. 4

Gen Duane H. Cassidy — Commander in Chief
Brig Gen William H. Sistrunk — Inspector General
Col Richard W. Blatter — Director of Safety

Maj Thomas C. Weinzierl — Supervising Editor
Capt Donald L. Rosenberry — Associate Editor
Capt Michael J. Iltis — Associate Editor
Mrs Frances A. Caldwell — Managing Editor
Mr Tom O'Laughlin — Art Director



page 9



page 22

About the cover—Photos courtesy
Maj Peter H. Clark
436 MAW/PA Dover AFB, DE

FEATURES

4 **The Invisible Hazard**
Turmoil in the low-level environment.

7 **Cumulonimbi**
A subtle reminder.

9 **A Routine Day**
Or was it?

12 **Fallacies in Aviation Safety Concepts**
Don't believe everything you hear.

15 **Toncontin Warning**
Beware!

16 **Hangar Horrors**
Birds discuss hangar problems.

20 **Tornado**
Whirling killer.

22 **Functional Cockpit Design**
A very useful tool.

DEPARTMENTS

3 **Flying Hour Milestones**

25 **Mishap With A Moral**

29 **Quick Stoppers**

31 **Flyer Call**

The MAC Flyer is published by the Director of Safety, Military Airlift Command. The contents are informative and not regulatory or directive. Names of people and places in mishap stories are representative and not necessarily of the aircraft or equipment involved. Information in any article may not be construed as incriminating under Article 31, UCMJ.

Contributions, comments and criticisms are welcome. Write: *The MAC Flyer*, HQ MAC/IGFE, Scott AFB, IL 62225-5101, or Autovon 576-3534. The editors reserve the right to make any editorial changes in manuscripts which they believe will improve the material without altering the intended meaning.

Subscriptions are available from: The Superintendent of Documents, Government Printing Office, Washington, D.C. 20402. Changes of address for subscription mailing should be sent to GPO. Give both old and new addresses, including zip codes. USAF Active and Air Reserve Forces units establish requirements for this magazine through their publication distributor (DAPD). Other U.S. Military units should consult administrative directives. *The MAC Flyer* is published at an approximate ratio of one magazine for every five MAC aircrew members, and one for every twenty MAC Support personnel. Distribution X; OPR: HQ MAC/IGFE ISSN 0024-788X.

Flying-Hour Milestones

SMSgt Jimmie H. Connel, 185 TAS
MSgt Thomas J. Coleman, 97 MAS

Lt Col Grant R. Mulder, 64 TAS/CC
Lt Col Charles R. Waterman, 22 MAS

Lt Col John W. Gurley, 185 TAS
Lt Col James C. Schaffer, 57 MAS
Lt Col Christopher D. Thieke, 57 MAS
Maj John R. Ball, 312 MAS
Maj Arnaldo L. Delucca, 312 MAS
Maj Reuel S. Griffin, 304 ARRS
Maj Lewis J. Newhard, Det 1, 89 MAW
Maj John B. Paysinger, III., Det 2, 1401 MAS
Maj William S. Peterson, 928 TAG
Maj Rollin M. Reeder, 707 MAS
Maj Jess E. Searle, 8 MAS
Maj Craig H. Wetzel, 8 MAS
Maj Glenn A. Yachechak, 732 MAS
Capt James E. Aslin, 304 ARRS
Capt Michael C. Hadley, 97 MAS
Capt Robert S. Hart, 300 MAS
Capt Gerald W. Herring, 707 MAS
SMSgt Curtis D. Angell, 8 MAS
SMSgt Rolland R. Waddell, 57 MAS
MSgt James W. Daniels, Det 1, 89 MAW
MSgt Roger D. Giel, 304 ARRS
MSgt Russel E. Martin, 304 ARRS
MSgt Buddy B. Morehouse, 57 MAS
MSgt Albert A. Moreno, 304 ARRS
MSgt Lester R. Ramirez, 57 MAS
MSgt Paul J. Sutherland, 57 MAS
MSgt Gary E. White, 312 MAS
TSgt Douglas P. Glover, 8 MAS
TSgt Hertha Lejeune, Det 1, 89 MAW
TSgt Kenneth F. Lyman, 57 MAS
SSgt Steven L. Arnold, 62 TAS
SSgt David Colbert, Jr., 57 MAS

Maj Charles P. Jones, 304 ARRS
Maj John L. Kaseburg, 304 ARRS
Capt Dean P. Eisberg, Det 2, 37 ARRS
Capt Bruce E. Stradley, Det 2, 37 ARRS

Ranks and units are those at time of award. See MACR 900-3 for details on how to apply for your own milestone award.

The Invisible Hazard

What you don't know can kill you.

by Maj. Robert J. Korose
HQ AWS, Scott AFB, IL

Picture yourself flying a two-ship tactical mission at low-level. It's a beautiful, sunny day and the air is so clear you feel you could almost touch the nearby mountains. Although the weather forecaster mentioned a chance for occasional moderate turbulence, the air you're flying through is as smooth as silk. Suddenly your aircraft is slammed up and down, left and right. Everything in the aircraft is tossed about including the crewmembers not strapped in. As quickly as it began, it's over, and once again the air is smooth. You quickly assess the severity of the injuries. When you call #2, you are shocked to discover they didn't experience any turbulence at all. You may have had an encounter with a mountain wave rotor.

When the wind blows over rough terrain, the airflow is disturbed. The effect is similar to that when water flows over and around rocks in a stream producing swirls, eddies, white water, and standing waves. This mechanical turbulence also occurs in the air; the difference is you usually can't see the disturbances and variations in the air. However, you can tell they're there. The updrafts and downdrafts creating turbulence can make your flight more interesting, or ruin it, if severe enough. Just as in water, the stronger the flow, the greater the turbulence. Mountain waves (a.k.a. lee waves) can be expected on the downwind side of high terrain whenever the wind at the top of the ridge is within 30° of perpendicular to the ridgeline and wind speed exceeds 25 knots. Other atmospheric factors contribute to the strength of forming waves, such as winds increasing with altitude while the ridge summit atmosphere remains stable.

A jet stream at high altitude which runs perpendicular to the high terrain usually provides ideal conditions for mountain wave formation. These waves can occur anywhere the terrain rises more than 300 feet above surrounding terrain. The key is the strong wind. Even if the atmosphere is unstable and a mountain wave doesn't form, the mechanical turbulence will be significant.

The most severe turbulence produced during a mountain wave condition occurs in the roll cloud or rotor circulation. These rotate like tornados, only horizontally, and

can literally tear an aircraft apart. Like tornados, their effects are extremely localized. This explains why you, in the lead aircraft in our example, experienced severe turbulence while your wingman remained in smooth air. The rotor isn't the only place in a mountain wave where you can expect turbulence. Pilots have reported mountain waves at all altitudes, from the surface to 70,000 feet. In many cases, the tropopause is the most significant high altitude turbulence area.

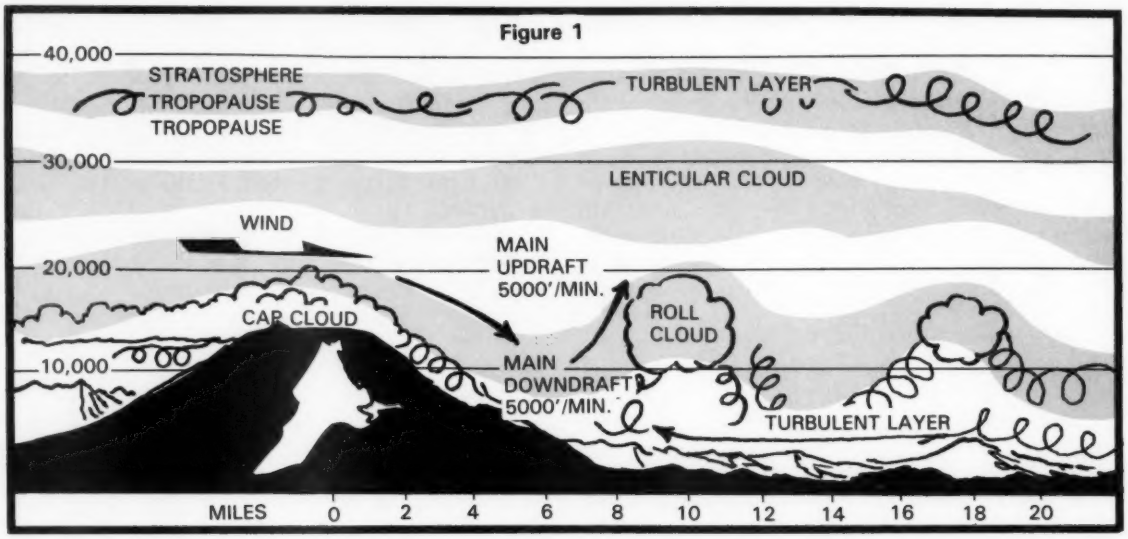
While the turbulence aspect of mountain waves certainly deserves your attention and respect, it is not *always* the most dangerous condition associated with the mountain wave condition. What could be worse? Consider atmospheric conditions which cause significant errors in your pressure instruments (like your altimeters and VVIs.) Here's how it happens. Air is forced over the windward side of a mountain ridge, accelerates at the summit, and then plunges down the lee, or downwind, side. Further downstream, it is forced upward again, forming the first wave. Depending on atmospheric conditions, multiple waves can be generated downstream for up to 300 miles. The downwind flow of air affects an aircraft in two ways—both bad. First, the wind can take the aircraft downward with it, and the airflow can change the angle of the relative airflow over the wings, decreasing lift in some cases. One compensating reaction is to add power, but considering the magnitude of the downdrafts, even max power may be inadequate compensation. With your pressure instruments adversely affected, you may not have any instrument indications of the descent. In fact, they can even indicate a slight climb while the aircraft descends through a layer equal to the induced altimeter error. The largest altimeter errors will occur near the crest of the highest terrain. In all cases, the altimeter will indicate higher than your "real" altitude. We've been taught for years to believe our instruments, and rightly so, since "seat of the pants" flight is pretty risky. But what about those instances where our instruments *aren't* reliable? What causes this phenomenon? Well, there is a significant drop in barometric pressure because air accelerates as it flows over a mountain ridge, just as it rushes over an airfoil, with the same resulting venturi effect. This means your altimeter is reading correctly, but the compensating pressure reading manually inserted in your Kollsman window isn't representative of the conditions of the mountains over which you are flying; consequently, the altitude readout is in error. The largest documented altitude error was reported by a helicopter that actually measured 2,500 feet of altitude deviation while landing on the side of a mountain during a strong wave condition. Another factor affecting pressure instruments is a change in relative wind or angle of attack when the downdraft is encountered. The airflow is not parallel to the horizon, but has a changing downward component. This affects the airflow over the static ports and into the pitot tube and can contribute to the altimeter and VVI errors. This disturbed airflow can also affect the indicated airspeed. The bottom line is: avoid flight at low altitudes near high terrain when there are strong winds. A phenomenon known as low altitude wind shear is related to the change in relative wind angle. Popularly known as *low-level* wind shear, this is another intense hazard associated with mountain wave situations.

Take a look at Figure 1. It's not hard to see the probability of a downward flow of air splitting into opposite direction flows. Notice the direction of flow of the surface winds downstream from the high terrain. The wind has actually reversed direction and is blowing toward the mountain! This creates an obvious contrast in winds aloft, resulting in a classic wind shear. The effects of this condition on an aircraft taking off away from the mountains are all too clear, as the aircraft would fly from a weak headwind into a strong tailwind. Now that we're aware of the problem, what do we do?

The next step is to try to learn to identify mountain waves. But how can you identify what you can't see? The answer is to identify the condition indirectly. Here's how. Most of the time (roughly 80%) there will be at least a few clouds present to indicate the occurrence of a wave condition. These clouds, unique to mountain wave conditions, can provide adequate warning:

- CAP CLOUDS: These clouds hug the high terrain and at times appear like a waterfall flowing down the lee side of the high terrain. Beware! These clouds obscure the high

Figure 1



terrain and are coincident with strong downdrafts.

• ROLL or ROTOR CLOUDS: These often appear as lines of small cumulus clouds parallel to the mountain ridge at about the elevation of the high terrain. Appearing harmless, rotor clouds are dangerously turbulent, housing updrafts of up to 5,000 feet per minute in the leading edge and downdrafts of equal strength on the downstream side. There is a constant boiling motion in and below these clouds, but the rotation is seldom apparent to the pilot. Time-lapse photography dramatically shows the rotor is there— *keep away!*

• LENTICULAR CLOUDS: These clouds form on the crest of the waves and appear stationary despite the strong winds blowing through them. At times, they occur in layers which can extend to 40,000 feet (thus the name altocumulous-standing-lenticular.) In addition, there may be several consecutive lenticular clouds downwind, each marking another mountain wave. These clouds appear quite smooth and beautiful, but severe turbulence and strong up and down drafts are nearby.

In addition to these tell-tale clouds, blowing dust may indicate the occurrence of a mountain wave. The strong winds and downdrafts can kick up dust as they surface downstream from the mountain ridge. When the air is very dry, this blowing dust may be the only visual clue to the presence of a mountain wave condition.

Having addressed identification, we turn now to methods we can employ to reduce the risk.

• Fly at an altitude equal to the elevation of the highest terrain plus at least 50% of the difference between the highest terrain elevation and the surrounding terrain elevation.

• Approach ridgelines at a 45° angle. This allows a quick turn away if a downdraft is encountered.

Watch for the visual clues described earlier for mountain wave conditions and *use* the information—avoid the hazardous areas.

• Suspect altimeter readings.

• Avoid IMC where possible.

• Use turbulence penetration airspeeds in areas of possible mountain waves.

• Report encounters with or observations of mountain waves as PIREPS to the nearest Air Weather Service forecaster, as well as ATC.

A graduate of Texas A & M University, Maj. Robert J. Korose is the aviation meteorologist who writes and maintains AFM 51-12 Vols I and II, "Weather for Aircrews." He has over fifteen years experience in aviation meteorology. Major Korose is a command pilot with over 5,000 accident-free flying hours in C-7A, CT-39, WC-135B and WC-130 E/H aircraft.

Cumulonimbi

Close may be too close.

by Capt. Michael J. Iltis
Associate Editor

Aircrews continue to encounter the disastrous effects of flying too close to, or through thunderstorms, in spite of training and warnings by flight safety officers, commanders, and DOs, and the technological advances in weather forecasting and weather-avoidance radar. Therefore, it is appropriate to remind everyone of the hazards associated with thunderstorms in aviation.

One of the reasons MAC aircraft and crews experience so many thunderstorms is our global, 24-hour-a-day mission. Combine this with the fact meteorologists estimate over 44,000 thunderstorms occur daily around the world, and it's easy to see why MAC aircraft are so vulnerable to this weather phenomena. What is it, then, that makes thunderstorms so common? The answer is the relatively simple structure of such a storm.

Recipe for a Thunderstorm

Take a measure of unstable air, add an abundant amount of moisture, shake well using some lifting mechanism (orographic or thermal), and you have all the ingredients of a cumulus cloud. If the ingredients are available in ample quantities, the cloud grows vertically due to moisture carried aloft by updrafts. This stage of thunderstorm development is characterized by an unmistakable "boiling" at the top of the cloud.

The cloud continues upward as it becomes a cumulonimbus cloud (thunderstorm) and the top flattens due to strong upper level winds. By this time, raindrops and ice particles have grown so large that their weight can no longer be supported by the updrafts and precipitation falls, cooling the air in the process. This creates the downdrafts associated with these storms. Couple this with cloud-to-cloud and cloud-to-ground lightning created by the interaction of the positively charged cloud top and the negatively charged bottom, and you have successfully mixed a real boomer.

Significant Storm Hazards

For those on the ground, the hazards associated with thunderstorms can usually be dealt with by seeking adequate shelter. But for those who venture into the sky when conditions are right for thunderstorm development, these hazards aren't so easily negotiated.

0 Wind. High winds are the calling cards of thunderstorms. For aviators, these winds may be divided into four categories, the first of which is the gust front.

Gust front winds (better known as first gust winds) extend outward up to 20 miles from the leading edge of the storm and vary in velocity and direction in relation to prevailing winds. Gust front winds increase the **average** velocity of prevailing winds by 15 knots. Keep in mind, however, that these winds have registered in excess of 100 knots! Likewise, changes in wind direction of 40° to 180° are also a trademark of the gust front. This variance of wind velocity and direction combine to create wind shear. Wind shear is particularly dangerous because of its effect on aircraft taking off or landing. The loss of headwind component, along with a change in the angle of attack of the relative wind, can reduce aircraft airspeed and result in a loss of lift at low altitude.

The second category of thunderstorm related winds are those created by microbursts. Though microbursts can occur in less severe weather conditions, they also take place under or on the edges of a thunderstorm. Microbursts act like mini-thunderstorm cells, creating the same type of downdraft winds over a very small area. An aircraft transiting a microburst can expect to encounter *rapid* changes in wind velocity and direction along with violent downdrafts. The insidious danger of a microburst is that its effects can be experienced in clear air, well

in advance of, or behind, the thunderstorm.

Violent updrafts and downdrafts are the third category of winds you will find in a thunderstorm. These winds are integral to thunderstorm development because they are necessary for the storm to mature. Updrafts and downdrafts result from orographic or thermal lifting and heat exchange within the cloud. Aside from creating turbulence (which we'll discuss later), these rising and falling air currents change the relative angle of attack of the wind as it flows over an airfoil. This requires an accompanying change in aircraft power/attitude in order to maintain altitude.

The final category of hazardous winds is the tornado. Sometimes, air is drawn into a thunderstorm with tremendous force. This air rotates and increases in velocity, forming a funnel-shaped, low pressure vortex. If the funnel touches the ground, it's classified as a tornado. If it doesn't, it's called a funnel cloud. In any case, the high winds that form this cloud spell disaster for airborne aircraft. (See related article, page 20).

- Turbulence. Thunderstorm-related turbulence is generated by the effect of converging updrafts, downdrafts, and circulating wind currents. The area within the thunderstorm where turbulence is likely to be severe is between the updrafts and downdrafts. Outside the cloud, wind shear turbulence may be felt 15 to 30 miles away from the cell. The intensity of turbulence depends largely on the size, weight, speed, and design of the aircraft; but with updrafts and downdrafts that can exceed 6,000 feet per minute, a rough, aircraft-stressing ride is assured. Sometimes, turbulence associated with gust front activity will show itself as a roll cloud. These clouds are capable of producing extreme turbulence well in advance of precipitation.

Altitude permitting, aircraft entering significant turbulence are better off "riding the wave," maintaining a level attitude and constant power setting. Attempting to compensate for turbulence using power and attitude adjustments may result in increased airframe stress.

- Hail. During the initial stages of thunderstorm development, moisture is carried aloft by rising air currents. As this moisture rises, it begins to condense and cool. Once these water droplets begin to freeze, they can combine to form hail. The size of hailstones varies with the amount of moisture in, and vertical development of, the storm. When updrafts can no longer support the weight of hailstones, they fall. As they fall, they begin to melt and may reach the ground as rain. Remember, rain at your altitude doesn't mean it's not hailing a few thousand feet up.

Obviously, encountering hail in flight can ruin your whole day. You increase the possibility of flying into hail anytime you are within 20 miles of a cumulonimbus cloud, especially beneath the anvil-shaped "blow off." Weather-avoidance radar does not always paint hail. Hail thrown outside the cloud into clear air is often invisible to radar.

- Icing. Not all moisture carried aloft turns to rain, hail, or snow. As the temperature decreases below 0°C, water vapor and droplets supercool to create an in-flight icing hazard. Flying in the 0 to -20°C temperature range, you are likely to encounter the most severe accumulations of clear ice. At temperatures between -10°C and -20°C, rime or mixed, rime and clear ice are probable. Icing can even occur at -40°C in some thunderstorms. Thunderstorm icing is particularly dangerous because it occurs rapidly.

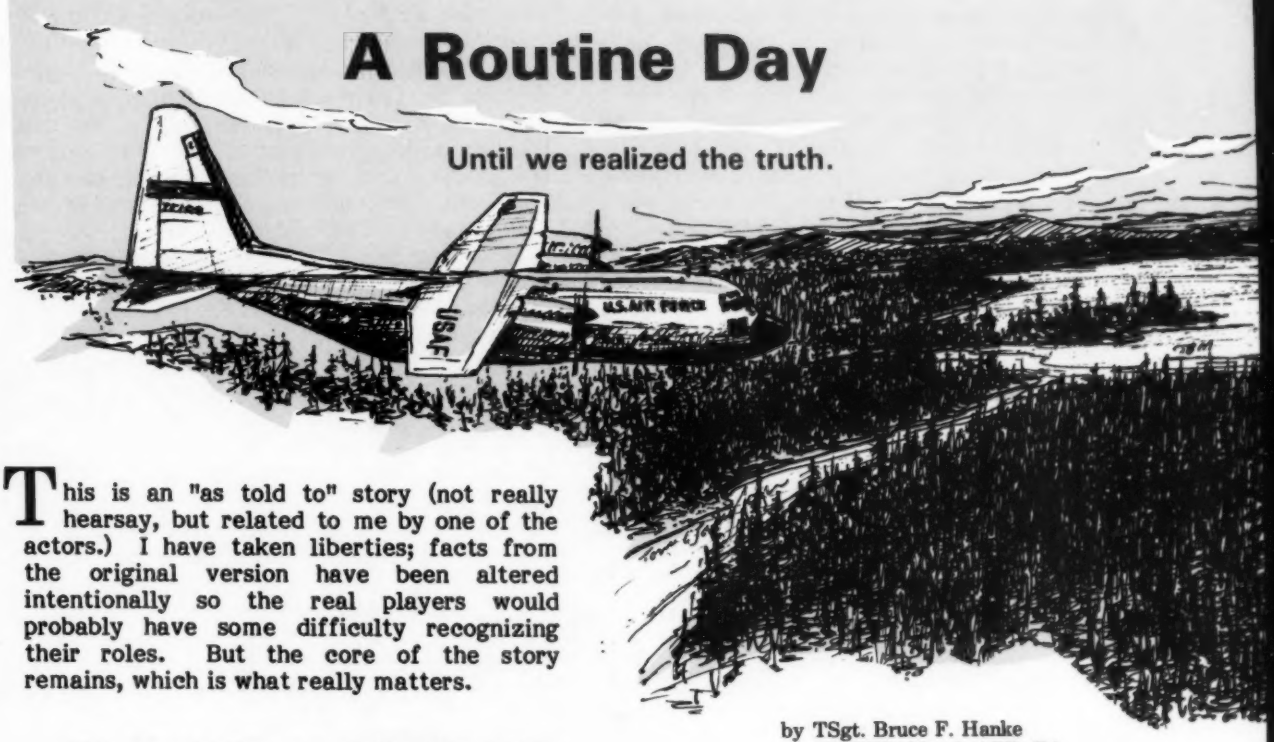
- Lightning. Lightning has been known to destroy airborne aircraft. Though advances in fuel system design have reduced such occurrences, the potential still exists, particularly for aircraft fueled with JP-4. Other hazards include temporary blindness and aircraft electrical, instrument, radar, and skin damage. To minimize chances of a lightning strike, avoid prolonged flight through precipitation when OAT is between 8°C and -8°C. Additionally, flight through upper levels of thunderstorms may trigger lightning that otherwise wouldn't occur.

So What's the Bottom Line?

Stay clear of thunderstorms! That sounds simple enough. Know that thousands of these storms occur every day. Recognize that cumulonimbus clouds contain every known aviation weather hazard. Above all, don't let your weather-avoidance radar capability lure you into the fatal misconception that it is there to help you *penetrate* severe weather—*it's not.*

A Routine Day

Until we realized the truth.



This is an "as told to" story (not really hearsay, but related to me by one of the actors.) I have taken liberties; facts from the original version have been altered intentionally so the real players would probably have some difficulty recognizing their roles. But the core of the story remains, which is what really matters.

by TSgt. Bruce F. Hanke
163 TFB, March AFB, CA

This story begins on a routine day, with a routine mission and, with all due respect, a routine crew. We even had routine problems. Perhaps the whole trip was just a little too routine, and maybe what happened *really was* caused by equipment malfunction. I don't know. It's just possible some unknown gremlin really did get in the compass systems, "helping" us stray off course. Whatever it was, I'll never forget that day.

We were flying along, "fat, dumb, and happy," as the saying goes, and before we recognized it, we had flown way south of where we thought we should have been. But that's just part of the problem. You see, we weren't thinking.

I'm Col. Jack Matlock. I was the aircraft commander that day. Frankly, I feel pretty lucky to be able to tell this story. Most people who err as we did don't get a second shot. We were on a joint exercise in Canada, which involved picking up and dropping off troops and cargo. We were on our third leg, headed for Fort Simpson from Churchill on Hudson Bay. Our old 'A' model C-130 Hercules purred along smoothly over the Canadian wilderness for six hours before we noticed anything wrong. We hadn't seen much of anything but lots of plains, pine trees, and lakes. In fact, there were hundreds of little lakes scattered throughout the region. The landscape was absolutely gorgeous and very peaceful; hypnotic and completely unthreatening. We *thought* we reached all our checkpoints without any difficulties—everything seemed "ops-normal."

I suddenly thought I'd better confirm our position, so I jokingly asked the navigator, 1st Lt. Mike Parnell, if he had any idea where we were. The lieutenant wasn't exactly paying attention to what he was supposed to be doing, so my question took him by surprise and snapped him back to reality.

He asked me to hold on for a second, and he would get an exact fix. He plotted the

Honorable Mention 1985 Flight Safety Writing Contest

Omega's position on his chart and reassured me we would be coming up on Great Slave Lake in just a couple of minutes.

But there was no big lake. Not even a hint of it. The whole crew scanned the horizon looking for signs of the big lake, any big lake. Now, next to Great Bear Lake, Great Slave Lake is just about the biggest lake in Canada. It's so big that if we were anywhere near it we couldn't have missed it. Another half hour passed and still no lake. I was getting a bit concerned, maybe even a little agitated. Mike was unsuccessfully trying to take a celestial fix. I think his proficiency with the sextant was diminished because he relied on other navigation equipment too much.

Mike's words struck like lightning when he stated matter-of-factly that he didn't know where we were exactly. To say that Parnell was a little shook would be an understatement. He went on to say that he thought the compass was screwed up because his DR position on the chart showed us where he knew we weren't. He pointed out that none of the landmarks matched up, and that he thought we should inform ATC of our problem.

But, of course, I was too proud and didn't want to admit we were lost. At least not yet. There we were on a joint forces mission working with the Royal Canadian Air Force; we certainly didn't want to look bad. After all, we Americans have the biggest and finest Air Force in the free world.

But Parnell insisted on making the call informing them we were having compass problems. Whether we were or not, at least it would be a face-saving excuse when we made it back—*if* we made it back. We really didn't know what else to do. We also didn't know how long it would be before we reached safety. There's always the possibility of running out of fuel in a most inopportune place. And northern Canada is definitely inopportune.

So I decided we would call. I was convinced. I turned to the copilot, Capt. Owen Lawton, and directed him to make the radio calls, and gave him the frequencies. I think he tried nine frequencies or more before someone finally answered. A Canadian bush pilot was flying within range and answered our call. He couldn't see us, but told us to look for a forest fire with a river just west of it. That would be the Hay River.

About twenty minutes later, the copilot pointed out his window and told us he could see the smoke. I squinted, looked out his window and, sure enough, I could see the smoke off in the distance. We radioed the bush pilot to confirm our sighting before making any moves, and the Canadian told us to head upriver. He said we would find a small town with an airstrip about forty kilometers away. We could refuel and get our bearings there.

Unknown to us, however, our forest fire wasn't the only one burning near a river that day.

It took us another 15 minutes to swing around the 85 degrees and cover the 40 "clicks" we thought would bring us to the airstrip. There was no town, though. Nor was there any sign of a town or an airstrip for the *next* 40 clicks, either. That's when I *really* began to sweat.

We had 3,600 pounds of fuel remaining—less than 50 minutes of flying time. We *had* to find a place to land real quick. I asked Owen to try calling the bush pilot again. I was just beginning to think we weren't going to reach him when we heard a faint voice crackling in the headset. He said he could read us loud and clear. We couldn't hear him as well, but at least we could make out most of his words.

We told him there wasn't any town where he said there was, and we hadn't seen anything at all that resembled civilization. He wasn't surprised because he'd learned there was another fire burning near the Peace River. This unfortunate coincidence resulted in our identifying the wrong river. He had thought we were someplace near the Hay River, when actually we weren't.

"Have no fear," he said. "There is a place to land about an hour from where I figure you are now."

I distinctly remember my heart dropping to my knees--*we didn't have an hour's fuel remaining!*

But as we had few alternatives, we decided to try for the landing strip anyway. What other choice had we? If all else failed, we could bail out. We had enough chutes and no passengers on board, so at least we had that much going for us. I hoped we wouldn't have to do that, though. In my 23 years of

flying, I'd never had to abandon an aircraft, not even in Vietnam where I flew over 160 combat missions over some pretty rough territory. But I guess there's always a first time for everything.

We brought the old Herk around to the heading we thought would take us to the airfield. At that point we were almost *400 miles* south of where we should have been. Mike still insisted the compass was at fault, but I wasn't so sure. I kept my doubts to myself; we could iron that out later if and when we got the old bird down safely. Right then, the issue was irrelevant . . . .

Mike Parnell and I had flown together for close to three years and I knew he could navigate. We'd been in tight scrapes before, but nothing this tight. I suppose we all tend to get a little complacent with years of routine work, no matter what type of work it is. It was obvious Mike appeared somewhat bored before and during this particular flight. I guess you could say we all did. Whether he was willing to admit it or not, his "navigating" probably contributed to our being lost more than any "compass malfunction."

It's unfair to lay all the blame on him, though. I have to admit, as aircraft commander, I was ultimately responsible for the airplane and those on board.

As our fuel gauges crept closer to the zero mark, our confidence in being able to get out of this situation safely diminished accordingly. We scanned the ground below for signs of life—still nothing. We called our bush pilot friend again, this time telling him we were desperate. Our tanks were nearly dry, our fuel was down to maybe ten minutes flying time. His response was a lot louder and clearer. We thought maybe he was a little closer to us now.

Sure enough, he was. It was almost as though someone was watching out for us that day. He saw us and told us to swing around to the northwest about 40° and follow him. We did. In less than five minutes we spotted an airstrip and headed straight in for an emergency landing.

And we all lived happily ever after, right?

Well . . . not exactly. You'd think that after that we'd have been able to pinpoint exactly what went wrong. But we couldn't. The compass system appeared to ground check okay, as did all the other navigational systems. So, we gassed up and flew the airplane out of there the next day. We had no further problems. Once back home, the maintenance people checked the airplane from stem to stern. They bench-checked every single component of the compass system. They shook down every connector and harness assembly until they were absolutely sure there were no problems.

We tried to blame the compass. It seemed the natural thing to do. But maintenance ended up clearing our "discrepancy" with a "could not duplicate" entry, and the airplane never had similar problems after that.

The most important part is not that we almost ran out of fuel and nearly lost a multimillion dollar airplane in the Canadian wilderness. What is most important is, as professionals, we are the ones responsible for our actions every time we take an airplane up. Whether the aircraft is laden with cargo or full of passengers, we are responsible for every single minute of flight.

Likewise, a maintenance crew charged with maintaining aircraft is responsible for that aircraft every time they release it for flight. "Close enough," just isn't. There is no room for complacency, overconfidence, or a "close enough" attitude. Doing our best is what really matters.

Following his active-duty Air Force service, which included tours at Tuy Hoa AB, Vietnam, Clark AB, Phillippines, and McGuire AFB, NJ, Sergeant Hanke joined the Rhode Island ANG in 1973. His experiences with MAC maintaining C-141s and C-130As ended in March 1985, when he accepted a job as an Avionics Instrument Systems Technician with the California ANG working on the F-4C.

by Jerome F. Lederer
Institute of Safety and System Management, USC

Aviation mishap investigators, safety practitioners, and crewmembers may be subjected to a variety of questionable beliefs, suppositions, or postulates that have developed over the years. Even safety veterans have become intellectually welded to dogmas that are often well founded but not invariably true.

Among a sample of such beliefs are: that all accidents or undesired events are the result of a sequence of proximate, preventable circumstances, i.e. the domino theory; that the interiors of all-metal, well-bonded aircraft are immune to the effects of atmospheric electrical discharges including lightning strikes; and that redundancy is a reliable safeguard against single point failure.

The Domino Theory

The domino theory was the brainchild of a great pioneer in modern accident prevention philosophy, H.W. Heinrich. He proposed this concept in 1931 in his book, *"Industrial Accident Prevention."* He asserted that "The injury is invariably caused by an accident and the accident, in turn, is always the result of the fact that immediately precedes it." He went on to say that "A preventable injury is the natural culmination of a series of events or circumstances which invariably occur in a fixed and logical order." This is the concept of sequential events, "the domino theory." The domino theory is a very attractive concept, widely accepted and true for the cause of many losses, especially for industrial accidents.

Unqualified Acceptance of the Sequential Theory

A good example of the sequential theory is National Transportation Safety Board Report 3-1768 concerning a training flight on 26 April 1979. The ceiling was low, and it was raining. The instructor pilot, on a VFR flight plan, continued into adverse weather although he had been briefed about the weather in person prior to the flight. The visibility at the mishap site was one-quarter mile or less, mountains were obscured. The instructor was 55 years old, Air Transport rated with 5,000 hours. His blood alcohol level was .158. Among the dominoes in this mishap were alcohol impairment,

disregarding the weather briefing, and flying VFR in IFR weather.

However, there are some examples which cast doubt on total acceptance of the sequential or domino theory. For example, the most frequent cause of disabling injuries in air transport operations is the encounter with unexpected clear air turbulence.

Another unusual example is a rock fracturing the windshield of an air transport at 35,000 feet. The rock had been thrown into low orbit by an erupting volcano. No warning, no sequence, and hence, no domino. This happened three times in 1979.

But the most catastrophic examples of the inapplicability of the domino theory are the losses caused by birdstrikes. An Electra, taking off from Boston on 10 April 1960, struck a flock of starlings. Sixty-two occupants of the Electra were killed. A Lear Jet taking off from Peachtree Airport in Georgia on 27 February 1973, struck a flock of cowbirds. All eight occupants of the aircraft were killed. Many will recall the DC-10 takeoff mishap at Kennedy Airport in 1974. This birdstrike cost $35 million in damage but fortunately, no fatalities. Aviation experts have learned much about reducing bird problems around airports, but what can be done about encounters with birds at altitude? One such birdstrike, at 15,000 feet over Maryland, resulted in the death of 49 aircraft occupants. As a rule, the domino theory of loss prevails, but it should not be accepted as infallible.

Lightning (Atmospheric Electricity)

Another widely accepted belief is that the interior of all-metal aircraft is protected from lightning damage by the Faraday Cage effect. This means that the surface of aircraft covered with electrically conductive metals such as aluminum, shields the interior from electrostatic charges produced in the atmosphere.

Not true. Lightning strikes or static discharges have caused several aircraft mishaps. In fact, about one-half of all USAF weather-related mishaps are caused by lightning.

Lightning or atmospheric static can also cause pitting of metal skin, pitting of engine and other bearings, destruction of radomes, and radio interference. These are external effects. Fatal mishaps and serious incidents are usually caused by gaps in the metal skins such as access panels or unprotected fuel vents. These gaps permit the fuel inside the all-metal wings to be ignited by electrostatic charges. Examples of such fatal mishaps include a Constellation over Milan, Italy, a USAF C-130 over South Carolina, and a Boeing 707 over Maryland.

The internal effects of a lightning strike are equally disastrous. In 1977, a Boeing 727 descending into Seattle at night in IMC was struck by lightning that knocked out all three (three for redundancy) power buses. The pilot lost all radio communications, lights (except emergency cabin lights), and cockpit instrumentation dependent on the power buses. His remaining control instrument was a battery-operated standby horizon indicator. Fortunately, one of the three buses returned to power after several minutes, enabling the pilot to land safely.

Apollo 12, the second manned flight to the moon, lost instrumentation for several seconds after it was launched through a highly charged cloud over Cape Kennedy. Additionally, there is at least one reported case of an electrostatic strike causing loss of an inertial navigation system.

Even if the effects of a lightning strike aren't felt inside an aircraft, the results of a highly charged aircraft skin can be equally hazardous. The 11 August 1979 issue of *Flight International* reported that a Swedish Viggen interceptor's Heads Up Display (HUD) was damaged following a lightning strike. Likewise, flameouts of turbine engines have been reported. The theory is that the lightning attaches itself to the fuselage skin and is swept backwards into the air inlets, creating an ionized plasma that causes the engine to flameout.

The lightning hazard threatens to become more serious. For example, the energy crisis lead to the use of wider cut, more flammable fuel. Also, the accelerated use of computers with microcircuitry for control and instrumentation could adversely affect aircraft operations because the circuitry is sensitive to transient currents induced by atmospheric electricity.

The use of composites in the structure of aircraft threatens to increase the lightning hazard because Faraday Cage protection is

reduced. Even when the composite material is used in less vulnerable areas of the wing, the resulting discontinuity of metal shielding may increase the potential for electronic disturbance in the interior of the structure. One theory indicates that in all-metal fuselage shells, the currents induced by atmospheric electricity surge back and forth along the skin to create powerful fields. Non-metal surfaces, such as windows, promote the possibility of higher voltages due to resistance created by the gap in the metal shield. Composites may introduce similar problems with discontinuity of shielding.

Researchers are working on ways to reduce the hazards of lightning and atmospheric electricity. However, the point is that metal shielding may not protect an aircraft's components (and it's occupants) against this hazard.

Reliability and Safety

Reliability and redundancy to achieve safety raise problems of semantics. Reliability of hardware usually means that the article or system will operate without failure for a specific time. In the context of this discussion, redundancy means the existence of identical extra articles or systems in position to assume a function if one or more fail. Redundancy promotes reliability of a system.

It is not uncommon to speak of reliability and/or redundancy as being synonymous with safety. Fortunately this is often true, but again, this viewpoint should be regarded with skepticism. Not long ago the NTSB published a memorandum describing the reason for an unusually large number of wheels-up landings involving two types of very popular general aviation aircraft designed over 30 years ago. The probable cause of these mishaps was that the pilots were confusing the flaps control with the gear control. The retractable gear of these airplanes had a reliable mechanism with several decades of operational history. This example points out that mechanical reliability of a system does not insure that the system will be used properly. Reliability of any manually operated system is only as good as the person using it.

Mechanical reliability, per se, does not guarantee operational reliability. Reliability and safety are not always coincidental.

Reliability and Redundancy

Reliabilty of a system usually incorporates redundancy to provide alternate functional channels in case of failure. The earlier discussion of lightning referred to the failure of the electrical bus systems of a B-727. They were triply redundant but all three failed. Identical redundancy does not necessarily provide fail-safe systems.

A prototype of a fighter airplane crashed when identical metal tubes in each of two redundant hydraulic control systems failed simultaneously. Luckily, such occurrences are very rare, but the point is clear: Redundancy only *promotes* reliability, it doesn't *insure* it.

Identical system, or "clone" redundancy, may also induce the additional hazard of pilot complacency (a survey among highly experienced retired airline pilots gave complacency a rating of 52 percent as the most important human frailty likely to cause mishaps.)

John P. Rankin of Boeing Aircraft Corporation asserts that, "In fact, when redundancy is provided by identical components, location, or channels, susceptibility to common cause failures may be increased." Collocated wire bundles is an example. A fire or overheat in one can destroy others.

An analogy concerns the redundancy of flight crews. The copilot is presumed to assume control in the event the captain is disabled. However, if both eat poisonous food at the same time, they may simultaneously become disabled. Good practice, therefore, requires them to eat different food at different times.

This discussion of the domino syndrome, the Faraday Cage protection against lightning, the differences among safety, reliability, and redundancy, lead to a postulate or generalization which is basic to safety: **TAKE NOTHING FOR GRANTED.**

Application to MAC

MAC airplanes are well-designed and well-maintained but any mechanical device is susceptible to failure without warning. Don't let the presence of multiple systems make you complacent. Know and study your aircraft systems. If you're not prepared, the first domino to fall may be *you*.

Adapted from: the USAF Safety Journal

TONCONTIN WARNING

AIRCRAFT STRIKES TRUCK, KILLS CHILD

by Lt Col Frank Tetreault
USDAO Tegucigalpa, Honduras

Toncontin IAP, Tegucigalpa, Honduras, is infamous for its 7.6° visual approach to Runway 01 due to its location in a bowl surrounded by mountains of up to 7,500 feet. The proximity of a major road with heavy traffic including tall buses and trucks to the approach end of Runway 01 adds to the challenge of the approach. The faded yellow and black "Poor Man's" visual approach slope indicator (VASI) on the right side of Runway 01 is difficult to see. However, even when a pilot is "on glide slope," he will be looking up at houses, restaurants, and other buildings off his right wing as he/she is skimming down the hills that are directly under the final approach.

There are other considerations that increase the pucker factor for pilots landing at Toncontin. The field elevation is 3,300 feet. During the hot/dry season (February through March), 35°C temperatures raise density altitude to nearly 6,500 feet. All the associated phenomena of higher true airspeeds for approach and takeoff and longer distances required for stopping and taking off make Toncontin's 6,132 feet of asphalt seem to get behind the aircraft very quickly. In fact, the displaced threshhold of Runway 01 gives the pilot only 5,640 feet for landing. Pilots may use the 200-foot overrun of Runway 01 to increase their safety factor.

A final factor contributing to the challenge of this final approach is the uneven thermal heating experienced as the aircraft passes over trees, rocks, grass, and asphalt on short final. This convective turbulence creates areas of updrafts and downdrafts.

Unfortunately, all these factors came together on 5 February 1986 when the left main landing gear of a Piper Aztec (PA-23 light twin) struck and instantly killed a 12 year-old boy. The boy was standing in the back, on the side of a large rack truck as it drove along the highway near the approach end of Runway 01. The pilot landed the Piper without knowing he had hit anything.

There was one other similar mishap in 1970 when the left main landing gear of a Honduran Air Force C-47 collided with a civilian bus. The bus rolled and several people were killed.

There are many lessons to be learned from this recent tragedy:

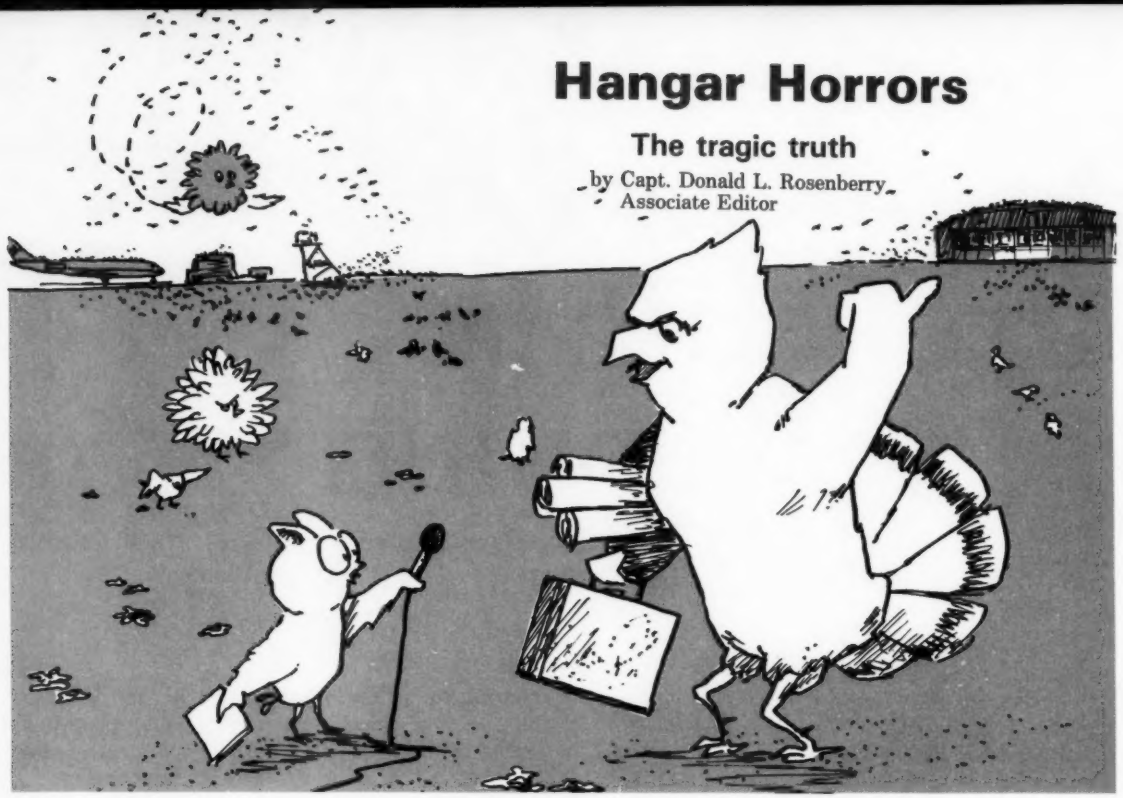
- Plan your approaches and know your aircraft's capabilities.
- Fly your computed takeoff and landing data.
- Maintain glideslope.
- Avoid fixating on your aim point.
- Scan the whole approach environment.
- Be willing to turn off at the end of the runway rather than mid-field.

US military pilots have been using all their professional skills to operate safely at Toncontin IAP. Please keep up the good work.

Hangar Horrors

The tragic truth

by Capt. Donald L. Rosenberry
Associate Editor



(Editors Note—While aircraft hangars are built as a sheltered environment for aircraft maintenance and inspections, they also provide a haven for such roosting birds as pigeons, starlings, and sparrows. Even when the doors are closed, birds gain entry to hangars via broken windows, small holes, and ventilation ducts. Once inside, they nest in the overhead structure. From that vantage point they are safe from the environment and can produce the most harm in the form of equipment damage, corrosion, and personnel safety problems—not to mention morale. Let's listen in on **their** side of the story.)

"Welcome to the second annual Strut-N-Crow competition! Coming at you live from Hangar 26 here at Yore AFB on 108.6 FM BIRD radio, I'm Barney the Brown-Eared Bul Bul. The excitement here has been building for months, and finally it's happening. The contestants and fans have been arriving all week, and it's pretty much roosting room only, especially near the main action. Originally scheduled as an outdoor event, the only cloud over this festivity was the announcement early last week that the event would be moved indoors. Coming as it did without warning, some of the contestants have already begun chirping 'fowl.' Their main complaint is the obvious effect on plumage. Milford, the Many-Feathered Muck Muck, favored to take the external presentation event, announced early last week he would call for an outside avian inquiry into the decision.

"Ah, here comes Tommy the Two-Fisted Zudzucker now. Tommy was elected committee chairman four months ago and has been deeply involved in the preparations. I'll move in and see if I can get another deep, hard-hitting, insightful interview."

"Excuse me, Mr. Zudzucker. I wonder if I might have a word with you? I represent the world's . . . ."

"With that outfit it's a cinch you don't represent the sighted. What d'ya want? I've had one heck of a day and I intend to knock back a long string of 'toenail curlers.' If you'd care to join me, we can continue this chat. Otherwise, go fly a locust."

"Uh, certainly. I'd love to share in the natural aged brew distilled and bottled here in the beautiful center of the southern migratory route to . . . ."

"Drop the commercial, drivel brain, and let's get moving!"

"Sure, Tommy, don't get excited. This is quite a place you've got here. What decor! Why, isn't this a contemporary composite avian imitation by *Duvanger* that exciting, new wave, french designer/decorator?"

"Wrong, Meatface. This is an aircraft hangar. We're doing all we can with what we've got—got that!?"

"Yes sir. I'm a little curious though. What precipitated the move indoors?"

"Let me put it this way. We're having a lot more trouble with those human creatures lately. For the safety of us all, I elected to move the event indoors, specifically to Hangar 7, since there weren't any of those jet propelled tennis ball cans inside."

"But this is Hangar 26!"

"Pretty sharp there Barn. I knew some of those synapses had to be working. As I was saying, there seems to be a particularly sneaky group of HBs (that's human being, to you) who go by the name B.A.S.H., I think. They don't seem to have anything better to do than cruise about messing up our lifestyles. They've been *real* busy this past year, and they've really stirred up the local HB clan. First, they convince the mass hordes of imitation fliers that we birds are the bad ones, then they teach 'em some grisly techniques for—eliminating our kind."

"You don't mean k-k-k-kill. . . ."

"That's right kid, I'm talking 'permanent stable condition'. First they messed up all the attractive spots outside, then they took to the buildings. Hand me another one of them oil-dipped Kalifournians, will ya? I just love these health food snacks."

"Sure, here you go. For all my listeners, Tommy, could you elaborate on the difficulties you've experienced?"

"You really think both of them care? We have had our share, though. In the beginning . . . ."

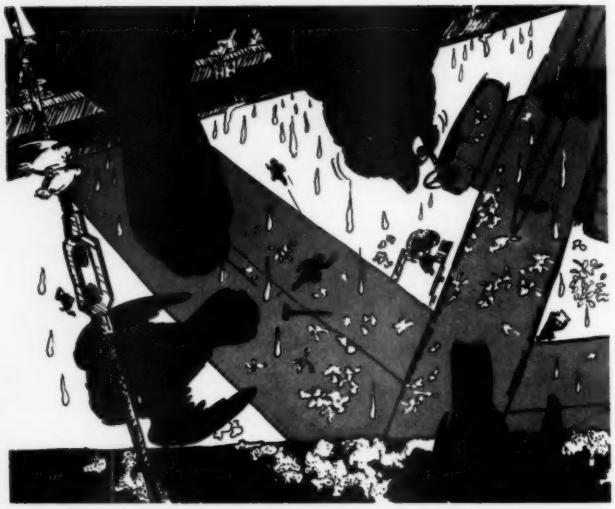
"Oh, you don't have to go that far back! Why not start after sunflowers were created? In fact, why not skip all the way to when you first moved indoors to Hangar 7?"

"Your head is not even considered in your thrust-to-weight ratio, is it? As I was saying, the HB's initial attempts were funny, almost ludicrous. Imagine, they brought in a bunch of stuffed owls and rubber snakes and hung them all over the place. Except for Sonny, who fell off his perch 'cause he was laughing so hard, and Clem, we just ignored 'em."

"Scared Clem pretty bad, huh?"

"Nah, he sprained his jaw on the rubber snake."

"He tried to eat it?"



"No, he was trying to make it eat something bigger than its head, like you always see on them animal shows. When it kept refusing, he tried to demonstrate. He never was too clever."

"I see. Well, if that's all they've done, I don't see how that . . . ."

"Not so quick, swizzle-beak. They moved on to more electronical type gadgetry. They brung in reflectors, lights, rotating beacons, strobes, loud music, and even a variable noise generator. 'Course, once they seen me and Fawn doing the Tommy Two-Step, named after me of course, they switched tactics in a hurry."

"It still doesn't sound too bad, Tommy."

"For once you are right, fat-beak, and if that was the end of this sad tale, we'd still be in Hangar 7. But then they turned to the devious, to the deliberately hurtful, in their no-holds-barred war on the winged."

"I had a feeling there was more."

"Sit down lad, this calls for another 'toenail curler,' and one of those gorga crackers with cheese."

"Right, here you go. Now about these 'techniques.'"

"Oh yeah. Well, you know how those I-beams up near the ceiling make such ideal perches?"

"Yeah, I know what you mean. Pretty neat the way they put those in there for us."

"Well, we were just sitting up there taking aim on our foes below, so to speak."

"A little aerial bombardment of the chemical kind, eh?"

"Right you are. Used to tickle me to death watching them HBs run when we all launched on command; or when we picked out a target and went for concentration. The next morning the HBs wouldn't even touch it. And you shoulda seen the hangar caretaker's face when we deposited about an inch of quality digestive by-product evenly over the whole floor. He never knew what was happening until he found himself lying on his back, sorta staring down the barrel, if you will."

"Sounds great. Maybe I oughta do a special on how to fight back against terrestrial bound riffraff after the contest, based on your proven techniques."

"Save your excitement, bulbface. The HBs don't take kindly to avian attacks. In fact, they get real mean. As I was saying, they started applying this chemical stuff to all the I-beams. I tell ya, it gets *real* uncomfortable trying to stand when yer foot's dissolving! Fortunately, the dust and dirt nature provided neutralizes the stuff pretty well, and when it gets hot enough in the hangar, the stuff melts and drips down on them."

"Sounds like justice to me! But why not just fly to another perch? They can't reach all the spots."

"Brilliant, Bubble-beak. Why do you suppose so few of us have bandaged feet? That's precisely how we defeated that effort."

"You still haven't explained how they made you move."

"Patience, sonny. The truly macabre remains. I guess it was last Tuesday it all started. We'd been out doing a little pre-game partying, if you know what I mean, so when we got back that night, we were all pretty tired. Just about the time we'd all settled in, lucky or not, all the lights came on! The doors were closed, all the holes sealed. Then they launched Harry, the Human-Honed Hawk and Freddy, the Fired-Up Falcon. It was grotesque! Time and again they did their basal predatory worst. After that, there was no way we were going to have our annual celebration in that tomb of terror."

"Sorry to hear that. So that's when you moved down here to Hangar 26?"

"Nope. Next we tried to move over to Hangar 15. But we found them HBs had installed some kind of huge plastic net. Of course, they had us, but some of the truly brave sacrificed themselves in the very topmost portions of the net. After a few days of having to use those huge machines to remove our friends, and then repair the nets, they removed 'em. Too expensive they said. That's what really set us up. We didn't know they cared about priceless avian life. Anyway, when we made it back in, there were all these very attractive perches placed here and there. In addition, there were boxes of corn placed in all the convenient locations."

"Sounds like the HBs finally decided to let us have one hangar in return for letting the others be."

"That's what the first 26 fans thought when they went inside. Before I could warn them, it was too late."

"Too late?"

"Let me tell you something. I know all about thrills but, poison from a tainted perch streaking up yer leg ain't exactly one of them. Why, there's no feeling in them HB's massive forms at all. They even used that Avitrol stuff. The kind that makes you scream and wail while you die in agony. Absolutely heinous!"

"What more could they possibly do?"

"Glad you asked that. They even started bringing in a group of HBs with these long metal cylinders. I'm not sure what they were, but being near 'em was terrifying. You look down at them HBs. They hold up the cylinders, jerk their shoulders and make an incredible screaming noise. It's so loud and sharp that if they point the cylinder at you and make the noise, your body literally explodes!"

"How on earth did you fight that?"

"You got to keep yourself between them and something they value. Apparently the noise will damage their stuff too, and you know how protective they are of those ridiculous metal containers. After a while, they gave up, but what a toll in talent."

"I guess that means this'll be the last of the annual Strut-N-Crow contests, eh?"

"You amaze me. I guess there's truth to the rumor about over-exposure to bright lights. There will always be celebrations. The more vigilant the HBs, the more perseverant we'll be. We're going to beat them yet. We're the *real* fliers!"

Ominous storm clouds over Southwestern Oklahoma on 11 May 1982 spawned a tornado that ripped a path of destruction through Altus AFB and left behind 27 injured people, $12.5 million in property damage, and over $3.6 million in damage to 11 aircraft on the parking ramp.

On 3 and 4 April 1974, the most severe outbreak of tornadoes ever recorded (in terms of number of tornadoes and amount of damage) occurred in the central and southeastern sections of the United States. One hundred and forty-seven tornadoes struck these areas in a 16-hour period, killing 335 people, injuring over 5,000, and creating an estimated $600 million in property damage. Suffice to say springtime is an appropriate season to discuss this weather phenomenon.

Though it is ludicrous to believe any pilot would intentionally fly an aircraft through one of these funneled monsters, the possibility of flying through the parent storm is much less remote. Whether in flight or on the ground, knowledge of what constitutes a tornado and its warning signs is essential to survival.

A tornado is a violently rotating column of air in contact with the ground. The air column is visible when it contains condensation or surface dust and debris. Often its appearance is a combination of both.

When a tornado touches the ground there is usually a swirl of dust and debris even when the cloud portion is missing. If the column of air doesn't reach the ground, the visible portion is properly called a funnel cloud. A waterspout is a funnel cloud in contact with a water surface.

Tornadoes vary greatly in size, intensity, and appearance. About 62 percent of all tornadoes fall into the *weak* category—wind speeds in the range of 100 mph or less. Weak tornadoes account for less than 3 percent of tornado deaths. About one in three tornadoes is classified as *strong*. Wind speeds reach about 200 mph with an average path length of 9 miles and a width of 200 yards. Almost 30 percent of tornado related deaths occur due to this type of storm. Nearly 70 percent of tornado fatalities result from *violent* tornadoes. Although rare (only about 2 percent are violent), these tornadoes can last for hours. Average path lengths and widths are 26 miles and 425 yards, respectively. The largest may exceed 1 mile or more in width, with wind speeds approaching 300 mph.

The color of a tornado is determined by a number of factors, including sunlight available and the type of debris picked up at the surface. The color of a tornado varies from one storm to another, and its shape changes frequently during its life cycle. During the late stages, it is not unusual for a tornado to become greatly tilted and shrink in size. However, this reduction in size doesn't mean that it is less intense. With exceptionally large tornadoes, the classic "funnel shape" may be absent. The tornado may appear to be a large turbulent cloud near the ground. It may even be mistaken for a large rain shaft or a non-weather event such as a fire.

Occasionally, two or more tornadoes can occur simultaneously, extending downward from the same thunderstorm. Tornadoes can also consist of a number of small, but intense, vortices that rotate about a common

center. With this type, the most intense damage is concentrated along the paths of the small vortices.

Except for weak tornadoes and water spouts, tornadoes usually originate in the rear quadrant of severe thunderstorms where circulation develops at heights between 15,000 and 30,000 feet. Tornadoes can also develop along the leading edge of a thunderstorm. While dangerous, these tornadoes are usually short-lived.

Tornado Facts That Can Save Your Life

- Groundspeed. Tornadoes travel at an average speed of 25 knots but may exceed 60 knots. Generally, they move from the southwest to northeast, but their direction may vary.
- Radar and inflight avoidance. Since a tornado is basically a severe wind storm, it is invisible to airborne weather-avoidance radar. What radar will show are areas of intense moisture within a thunderstorm. Radar may also depict moisture formations which are representative of tornado formation. These radar signatures appear as cloud fingers extending from the edge of the storm. However, the absence of these returns does not mean that tornadoes aren't present. The only insurance is to avoid the storm entirely.

When operating below the cloud bases, be particularly alert for hail. While hail may or may not precede a tornado, the portion of a thunderstorm adjacent to large hail is often the area where strong to violent tornadoes occur.

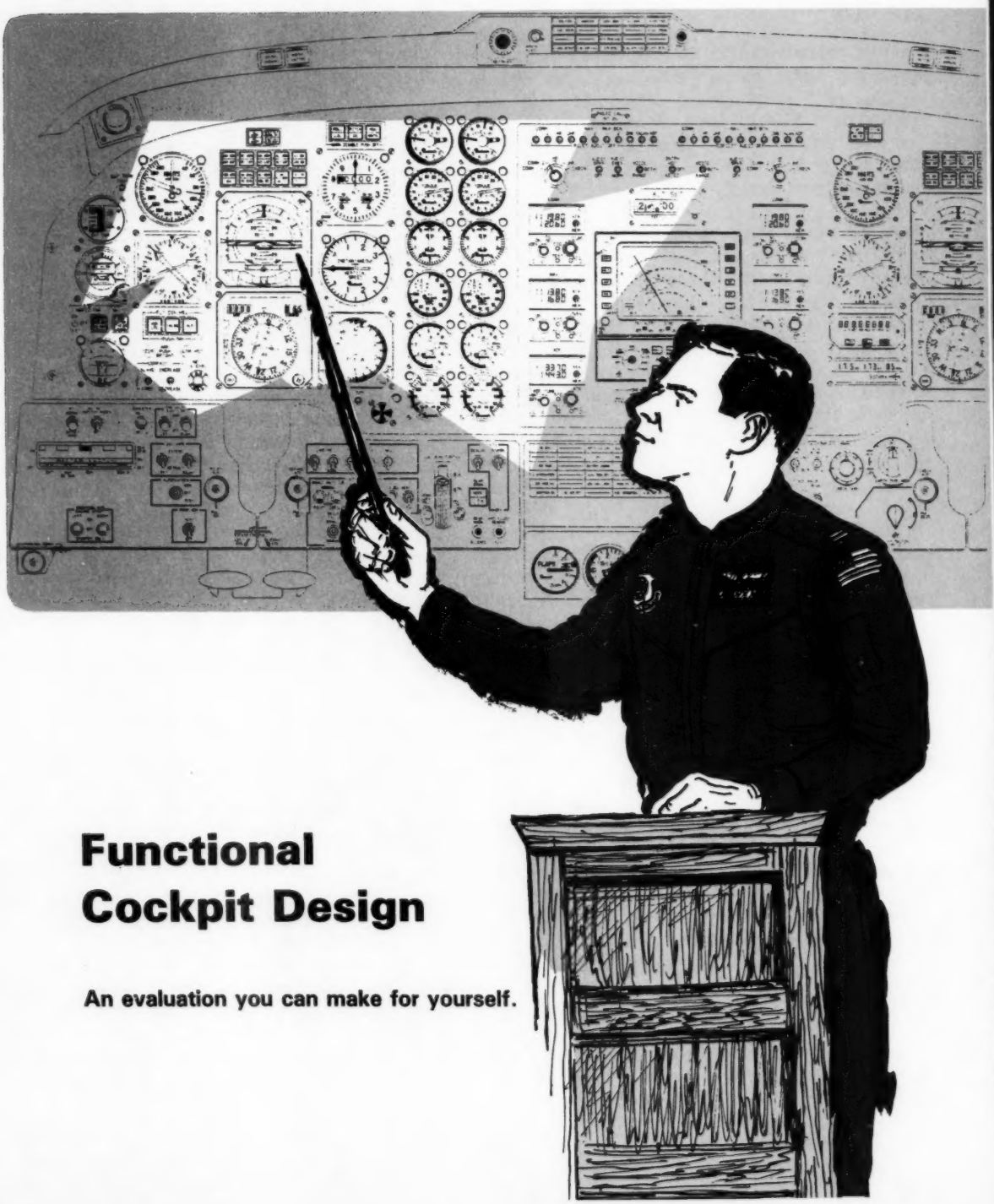
BEWARE OF TORNADO FALLACIES!

- "The severe vortices associated with a tornado are limited to the funnel cloud and lower levels of the parent thunderstorm." *Wrong.* The spiraling vortex winds of a funnel cloud extend well into the cloud. Any aircraft that inadvertently enters such a storm (or on purpose as in the case of some special mission aircraft) is certain to suffer structural damage.
- "Only thunderstorms with towering vertical development are capable of producing tornadoes." *Wrong again.* Though thunderstorms with high vertical development are obviously dangerous, perhaps the most hazardous condition for aviators is using radar to "pick" their way through a storm system that contains numerous embedded thunderstorms. These smaller storms can collide and create a larger storm or even a "super cell." A "super cell" is the thunderstorm cell most likely to spawn tornadoes.
- "If on the ground, opening a window in a tornado shelter will significantly reduce damage." Most structures have sufficient ventilation to allow for the sudden drop in atmospheric pressure. The National Weather Service recommends *not* opening a window. If a tornado gets close enough to a structure to induce the pressure drop, strong winds will have already caused significant damage.
- Survival. For airborne aviators, the key to survival is to avoid severe weather. At the National Severe Storms Forecast Center (NSSFC) in Kansas City, Missouri, meteorologists monitor atmospheric conditions in North America using surface weather observations, radar information, satellite photographs, temperature, moisture, wind speeds at varying levels of the atmosphere, and pilot reports. This information provides forecasters with reliable information to forecast the storms most likely to produce tornadoes. Professional flight planning, which includes thorough weather updates enroute and at stopover locations, along with the proper use of weather radar, provides aircrews with all the tools necessary to avoid these storms.

When conditions are favorable for the occurrence of both severe thunderstorms and tornadoes, the NSSFC issues a *Tornado (Severe Thunderstorm) Watch.* If radar indicates, or surface observers spot severe thunderstorms and/or tornadoes occurring, forecasters issue a *Tornado (Severe Thunderstorm) Warning.* In either event, persons on the ground should take shelter and prepare for the worst. Remember, tornadoes can spawn out of any thunderstorm.

Whether on the ground or in the air, the key to surviving one of these killer storms is prior planning. Pay heed to weather forecasts. If airborne, don't make the fatal mistake of using weather *avoidance* radar as weather *penetration* radar. Tornadoes, and the weather conditions which create them, should not be taken lightly . . . they're killers.

Adapted from the National Oceanic and Atmospheric Administration's Tornado Safety: Surviving Nature's Most Violent Storms



Functional Cockpit Design

An evaluation you can make for yourself.

"Will you be at the flight safety meeting this morning, Colonel?" Capt. Brad "Mac" Mackenzie asked the wing commander.

"Sure will, Mac. I understand you'll be presenting a study in functional cockpit design evaluation, correct?"

"Yes sir. I think our recent mishap experience has demonstrated, among other factors, the danger of allowing a warning device, either through multiple activations or bad design, to stop acting as a warning."

"That ought to prove interesting. I'll definitely be there, as I usually am for safety meetings. See you in half an hour."

"Yes sir."

"Hey Mac!" The other captain's voice resounded in the tiny hallway. "C'mon. I'll give you a ride down to the squadron."

"Thanks." Brad gathered his prepared briefing notes in his leather briefcase and swung his trim, six-foot frame toward the exit.

"Sure is nice of you to offer me a ride."

"Well, Mac, this is a big command, and we've all got to work together to get the job done right," Capt. Kathy Smith philosophized. "Here's the squadron. Jump out and I'll go park the car. See you in a few minutes,"

"Thanks. I'll head on in to the briefing room and get set up. I've only got about fifteen minutes until the meeting begins." Mac grabbed his briefcase and jogged to the squadron entrance. Inside, he found a large portion of the squadron already in the briefing room. He strode confidently to the front and asked Lt. Col. Samuel Hartch, the wing Chief of Flight Safety, "Sir, what does the meeting agenda hold in store for us today?"

"Well, Captain," the colonel began, "as usual, Col. Alfred Martin will begin the meeting with a few comments. After that, the floor is pretty much yours. I understand you have a fairly lengthy presentation, so we cancelled the scheduled discussion of Air Force Forms 457."

"Thank you, colonel. I will attempt to be brief. I try to limit my presentations to about 55 minutes."

"Take all the time you need, Captain. Your message justifies the time expended."

"*ROOM! ATTENTION!* Ladies and gentlemen, the wing commander."

Colonel Martin strode into the room and, while surveying the audience, walked crisply to the front.

"Thank you, Colonel Hartch. As you all know, our recent mishap experience is good compared to years past and other units, but not perfect. We can always improve our efforts to fend off those accidents waiting to happen, and one of our most effective weapons is education. Many mishaps could have been avoided had the right person had the right information available at the right time. I realize this is a simplistic description of a complex problem, but it succinctly states one of the goals of safety.

Today's aircraft are as complex as today's crewmember. Intercockpit communication is an art requiring deliberate effort and skill. With us today is Captain Brad Mackenzie from our Numbered Air Force. He has a presentation designed to get you thinking about the non-people part of the flight environment. The goal is to make oneself aware of problem areas, *before* time allows only a gut-level response. Captain Mackenzie."

Mac walked confidently to the podium. Those individuals who had never met "Mac" were immediately impressed. His lean, finely muscled frame, his air of confidence, and his friendly grin presented an impeccable, clean-cut image of a warm and approachable human being.

"Thank you, Colonel Martin. Ladies and gentlemen, I have a challenge for you. The next time you enter your aircraft, evaluate the design of your flight station. Does the physical layout of your work area enhance or detract from your responsibilities during routine flight? Have you ever tried projecting yourself into an emergency? How does your equipment fit into the picture of emergency checklists? These questions are inspired by much more than idle curiosity. We've all read of warning devices that cease to effectively highlight the problems they're designed to, either through overactivation or bad design. Likewise, we have all seen the efforts to overcome bad design through training. In either case, the key to the discussion resides in the definition of bad design—more accurately, inadequate design.

To define this concept would require an

The goal is to make oneself aware of problem areas before time allows only a gut-level response.

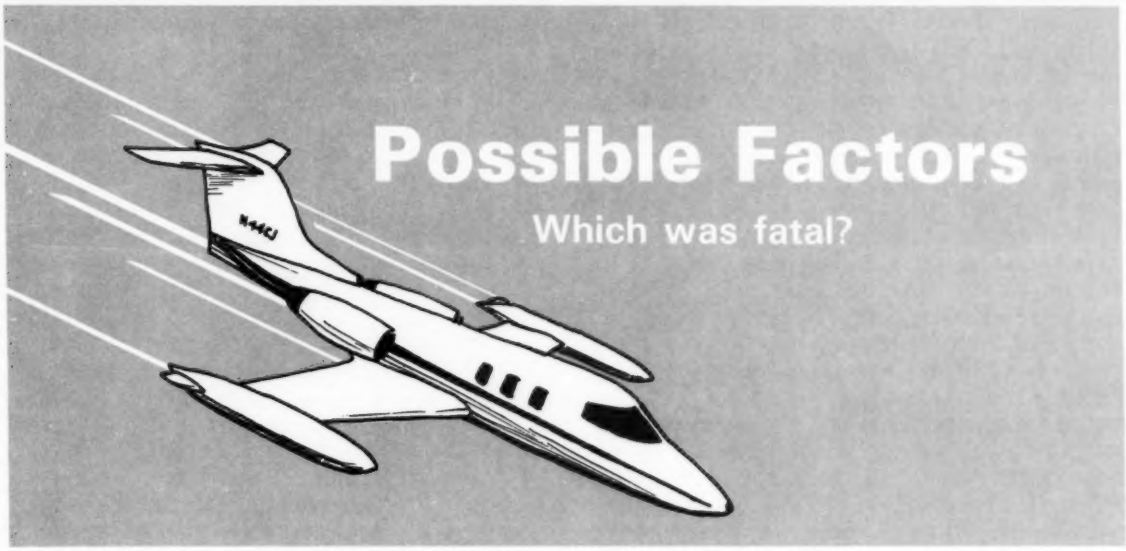
analysis of each of you—your personalities and motivations, as well as individual anthropometry. The task is overwhelming when applied to those of us here in this room, much less the whole command or US Air Force. This explains the noticeable lack of comprehensive works on this subject. Why bring it up? Because you can make the evaluation yourself. If it could be done and printed up for each of us, the obvious benefit would be that we would know which design features we 'fit' and which we don't. We could be reasonably sure which 'warning devices' would serve us, and which our individual make-up would filter out. More importantly, we'd be able to consciously develop a backup for the devices that don't work for us. How can we go about this type of analysis?

There are some relatively simple questions you can ask yourself which, when taken together, will give you a pretty good idea of how you and your cockpit interface. The questions are necessarily phrased for a single generic instrument, and this means you'll have to ask the same questions for each critical instrument you deal with, especially on takeoff and landing.

- Is this instrument or control reliable? This is a two-part question. Do others say it's reliable and do *you* believe it is? The principle involved is low reliability—real or perceived—elicits disuse, departure from standard use, or poor performance from lack of experience.
- How familiar are you with this control or instrument? If your flying experience is mostly in your present aircraft, this will not be a major factor. If, however, the preponderance of your experience is in a different aircraft, this could be a definite factor.
- Can this instrument or control be distinguished by feel alone? Any control to be operated during taxi (hover), takeoff, aerial refueling, formation, approach, landing, and rollout, must be distinguishable via tactile contact alone.
- Is this instrument readable under all conditions? Here you're looking for readability at differing light levels, positions, and in turbulence.
- Is this instrument or control easily confused with another?
- Are instruments for similar purposes grouped together? Do similar controls operate the same? Here we're cross-checking. If all the knobs turn counter-clockwise but one, you'd better know which one by heart or you'll surely operate it incorrectly under stress.
- Does this warning device attract the operator involuntarily? Warning devices *must* attract the crewmember's attention involuntarily. Warning devices which are constantly activating (how much is too much is a measure each of us must determine for ourselves) serve to inhibit the conditioned response they were installed to promote. The crewmember must then devise an alternate *active* backup to that warning system. If the the gear horn in your aircraft constantly sounds, then you'll have to associate the gear check with some other action, a principle known as transference.
- Does this warning device sound only in the situation it is supposed to guard? If not, again, you will have to consciously develop a check of the important possibility.
- Does any of your equipment reduce cockpit visibility or visual acuity—day or night? If normal operation of your overhead panel lights interfers with reading other instruments, you're going to have to make an adjustment.
- Are all the zero and maximum readings of similar instruments in the same relative position? Knowing the answer to this question can reduce a lot of strain.

Applying this analysis to your flight station can increase your margin of safety in any high-stress, fatigued, or fixed attention situation. I think we could all do more to work with the equipment we have *as is*, if we use this personal evaluation technique. The time you spend may save your life and the Military Airlift Command valuable resources, a professional crew and an aircraft."

Mishap With A Moral



Training, indoctrination, and familiarization are terms which don't exactly engender enthusiasm in the hearts and minds of aviators at large. But as the aviation world becomes more complex, filled with greater varieties of subtly different airframes with complex, specific missions, the reason for a well-planned, deliberate approach to flight preparation becomes ever clearer. On 1 October 1981, the crew of N44CJ, a Gates Learjet Model 24, confronted an insurmountable combination of "possible factors."

The president of Sky Train Inc., his chief pilot, and another company pilot began their departure from runway 21 at Casper Airfield, Wyoming, at 1357 Central Daylight Time (CDT). Their flight plan revealed their intention to return from a business trip in Casper, Wyoming, at FL 450 and 450 knots, via Denver, Colorado, to their company headquarters in McAllen, Texas. Fifty minutes after takeoff, the crew of N44CJ initiated radio contact with Sector 71 of the Albuquerque Air Route Traffic Control Center (ARTCC). The Learjet's transponder code was set to 0670 and functioning normally.

At 1458 CDT, a different controller took over the radar and data positions affecting the Learjet. At about this time he issued N44CJ a new radio frequency, but the crew didn't respond. The controller noted he was no longer receiving their transponder target reply either. He made several unsuccessful attempts to contact the aircraft until 1501 CDT. The Albuquerque ARTCC radar data computer showed that when the center lost radar contact with N44CJ at 1458:07 CDT, the aircraft was at FL 447. The aircraft crashed 2.5 miles south of Felt, Oklahoma, killing all three pilots aboard.

Analysis

This mishap clearly demonstrates the multiplicity of possible causal factors in flight mishaps. The National Transportation Safety Board's (NTSB) investigation was denied much critical technical information because the aircraft was neither Cockpit Voice Recorder (CVR) nor Flight Data Recorder (FDR) equipped. Therefore, they based their mishap analysis on personnel records, maintenance history, the FAA's Special Certification Review (SCR) report, meteorological information, conclusions about ATC radar data, portions of the wreckage, and knowledge gained through previous Learjet investigations.

The NTSB concluded the chief pilot and

company president were experienced pilots, although *inexperienced* in the Learjet. The president had accrued only 28.3 hours in the aircraft. The chief pilot, with a total flight time of 13,200 hours, had *no flight hours logged in the Learjet*, an aircraft for which he was type-rated. Based on their knowledge of Learjet operations, the NTSB concluded the pilot's lack of experience was a causal factor in the mishap. But there were other factors as well.

While several maintenance problems *may* have been significant in this mishap, no conclusive evidence was produced to support this premise. The board, however, finding no record of any inspections conducted since 2 December 1980, concluded that qualified maintenance personnel had not closely examined critical items on the aircraft in 10 months, despite a requirement for an inspection every 150 hours or 6 months, whichever occurs first. Consequently, they concluded items indicated as open discrepancies were not dealt with and were still open at the time of the mishap flight. These included, among other things, a pressurization problem resulting from a faulty lower latch on the main cabin door, and several autopilot discrepancies. Both of these problems could have been factors in this mishap. The continuing autopilot problem, the Board concluded, most likely resulted in the pilots avoiding its use. While there is no speed restriction on operating this model Learjet without the autopilot as with later models, its use would aid in stabilizing the aircraft in turbulent air.

Learjet aircraft have had other accidents of a similar vein which prompted the Federal Aviation Administration to take a close look at the aircraft. During a special certification review, the FAA's report revealed the aircraft has certain critical flight characteristics which require compensation through complex systems to insure an adequate level of safety.

The maximum operating Mach number (M_{MO}=.82M) results from the aircraft's marginal longitudinal stability characteristics. In order to be certificated for flight at FL 450, several modifications had to be made. A much stronger elevator downspring and a bob weight were added to help prevent a pilot from overcontrolling and thereby overstressing the airframe at high speeds and altitudes. Also, the aircraft was equipped with a single yaw damper to preclude a coupled lateral direction oscillation. To provide an even greater margin of safety, the Model 24 incorporates a stick puller system, which causes the aircraft to climb in the event of an overspeed. The automatic signal to the autopilot elevator servo actuator is triggered at Mach .82 by a Mach sensing switch. This puller exerts a force of 18 pounds on the control column. The aircraft is also equipped with an artificial stall warning system. This system employs a stick shaker and stick pusher to provide a prestall warning to prevent an abrupt wing rolloff. The stick pusher, when activated, forces the control wheel forward with a force of up to 80 pounds. The report summarizes findings regarding the Learjet's high speed characteristics, which are, in part:

- Mach tuck (nose down pitch divergence caused by aft movement of the center of pressure due to compressibility) begins prior to M_{MO}.
- Extension of the spoilers at high speed causes a large nose down pitching moment.
- Aileron "buzz" onset occurs just above M_{MO}; at higher Mach numbers and/or higher load factors, aileron "snatch" (rapid, large deflection aileron motion) occurs. Loose (misrigged) aileron cables could increase the amplitude and lower the onset Mach number, since the major factor which damps this motion is control system friction.
- The Mach overspeed warning and stick puller systems only operate from the copilot's pitot-static system. If an error in the copilot's system results in a low Mach reading for any reason, the overspeed warning will occur beyond M_{MO}.
- During approval testing on three different aircraft (one Model 25D and two Model 35s), the pilot's Machmeter stopped increasing at approximately 0.80 - 0.81 Mach and remained at this reading out to a true Mach number of 0.86. During the recovery, the Mach meter began working again at 0.805 Mach. The end result of the airspeed problem was that the production airplanes were actually going .01 to .015 Mach faster than the pilot's instruments indicated.
- Lear 25 TIR (Type Inspection Report) data shows that the speed increase after an upset was less if the spoilers were not used because the heavy nose down trim change made it

harder to get the nose up to 1.5 gs for recovery.

If a pitch upset occurs near M_{MO}, the airplane can accelerate rapidly into a region where the flying qualities are unacceptable. In the case of a nose down pitch axis malfunction (such as runaway trim, pusher hardover, autopilot hardover, etc.), the pull force required for the pilot to restrain the control column can be as high as 80 pounds. Because of reaction time, the speed will have increased beyond the limit Mach number. If the pilot follows the Aircraft Flight Manual (AFM) procedures for overspeed and deploys the spoilers (which is instinctive), the required pull force will increase an additional 80 pounds. Also, because of the pitch instability due to Mach tuck, the pull force will continue to increase as speed increases. Adding the maneuvering stick force required to pull 1.5 g, the total pilot force required for recovery can be as high as *200 pounds*. The stick puller was installed to prevent Mach overspeed, but in the case of a nose down pitch axis malfunction and/or deployment of the spoilers, its 18 pounds of pull is insignificant. If, after the pilot notices the overspeed, he deploys the spoilers, or if aileron "snatch" rolls the aircraft to an excessive bank angle, it may be impossible to recover.

Spoiler deployment became another focus for the investigation. Prior studies, initiated following previous mishaps, demonstrated the instinctiveness of deploying the spoilers in an overspeed condition. The AFM recovered from the wreckage contained the following excerpt in the limitations sections:
This was the prescribed procedure up until

[redacted]

MAXIMUM OPERATING SPEED V_{MO}/M_{MO}
These speed shall not be deliberately exceeded in any flight condition except where higher speed is specifically authorized for flight tests or pilot training operation or in approved emergency procedures. If inadvertantly exceeded:
1. Extend Spoilers.
2. Reduce thrust to idle.
3. Level wings if required.
4. Rotate nose up not to exceed 1.5gs.

[redacted]

1 October 1980, when a significant revision was approved based on the idiosyncratic high-speed characteristics of the Learjet. The "new" procedure, approved and disseminated one year prior to this mishap, reads, in part:

[redacted]

MAXIMUM OPERATING SPEED V_{MO}/M_{MO}
RECOVERY FROM OVERSPEED
If V_{MO} or M_{MO} is inadvertantly exceeded:
WARNING: Do not extend the spoilers, or operate with spoilers deployed, at speeds above V_{MO}/M_{MO} due to the significant nose down pitching moment associated with spoiler movement.
1. Thrust lever—idle.
2. Level wings if required.
3. Rotate nose-up not to exceed 1.5gs.

[redacted]

Analyzing the computer tapes, the NTSB discovered that at the beginning of the final descent, the aircraft experienced an increase in drag above that of the aircraft in a "clean" configuration. Analysis of the spoiler actuator indicated that at some point the spoilers were extended. An overspeed condition probably would have prompted the aircrew to deploy the spoilers. While aircrew incapacitation could not be ruled out, the evidence led the board to conclude the spoilers were deployed during descent, ruling out crew incapacitation as cause of loss of control.

What then, would have caused the aircraft to enter uncontrolled descent? The data showed the aircraft encountered an unexplained altitude excursion of greater than 300 feet, 40 seconds before the aircraft's beacon transmissions stopped. The area the aircraft was transiting was characterized by a confluent zone of polar and subtropical jet streams. Upper air soundings demonstrated a wind shear of greater than six knots per 1,000 ft at their altitude. The aircraft was also well within 6,000 ft of the tropopause, a region where clear air turbulence is likely. The board concluded that the weather pattern would have been conducive to moderate, and possibly severe, clear air turbulence at FL 450. The altitude excursion revealed by ATC tapes could be an indication the aircraft encountered moderate to severe turbulence.

The buffet margin for N44CJ was 41 KIAS, or about 0.14M. Since the aircraft was operating in a relatively narrow region of its flight envelope, loss of control could have occurred from a transient condition placing the aircraft outside either its high-speed or low-speed boundary. Both limits were

susceptible and although the NTSB couldn't determine which was exceeded, a loss of control could have resulted from either. A gust upset from either also could result in an overspeed. Based on the FAA's SCR report, Mach tuck can occur prior to M_{MO} and aileron "buzz" can be encountered just beyond this speed. Even momentary inattention by the aircrew could have allowed the aircraft to accelerate beyond M_{MO}, with an accompanying onset of abnormal pitch indications and a severe roll control problem without warning. If the flight crew had deployed the spoilers at this point, without instantaneously reducing thrust, the flight control column pull forces would have increased and speed instability and lack of roll control could have progressed to the point where it was impossible to recover the aircraft. Because the flight manual recovered from the wreckage did not include any of the current revisions (and the revisions were not located elsewhere in the wreckage), the Safety Board believes the flight crew probably did not have a current AFM aboard the aircraft. While this implies they might not have been aware of the revisions restricting the use of the spoilers, this could not be proven. The NTSB final report listed 13 findings. The five most significant follow:

- There was evidence of maintenance discrepancies which could have been factors in the accident.
- There was evidence of potential moderate to severe clear air turbulence in the area the aircraft was transiting.
- Loss of aircraft control could have resulted from even momentary inattention and a failure to react properly and in a timely manner.
- The flight crew probably deployed the spoilers at some point beyond airspeed limits in an attempt to regain aircraft control; this probably induced excessive control wheel forces and prevented aircraft recovery.
- The AFM recovered from the aircraft wreckage did not contain the current revisions.

Probable Cause

The National Transportation Safety Board determined the probable cause of the accident was a loss of control, possibly initiated by an unexpected encounter with moderate to severe clear air turbulence, which caused the aircraft to depart the narrow flight envelope boundaries in which it was operating and from which recovery was not effected; the flight crew's lack of adequate training and experience in the Learjet; and the aircraft's marginal controllability characteristics near and beyond the boundaries of its flight envelope. Contributing to the accident was the flight crew's probable extension of the spoilers in an overspeed situation, a procedure that had been prescribed in the approved flight manual until a year before the accident.

Application to MAC

There are a number of messages here for MAC's crew force, whether or not high-altitude, high-speed flight fits our aircraft's operating envelope. The details here lend credibility to MAC's policies of having aircraft commanders, transitioning to or between MAC aircraft, accrue a minimum number of hours with experienced crewmembers *before* certifying them as qualified ACs in their own right. The required minimum hours enable sufficient seasoning to learn the peculiarities of each different aircraft type. This leads, quite nicely, to the next concept involved in this mishap—training. The evidence leads one to believe that while the overall airworthiness of the Learjet was a matter of considerable concern (the FAA conducted a Special Certification Review), the crew was still unaware of current flight manual procedures. This seems even more distressing considering that two of the pilots were company executives.

Another problem was publication's currency. While it wasn't proven this flight crew perished due to outdated pubs, there is certainly some indication they used inappropriate procedures which may have prevented them from recovering the aircraft.

Throughout our flight careers we experience training programs, and occasionally the rationale behind the methodical approach to every problem loses its clarity in the humdrum of everyday operations. This mishap emphasizes the need for caution and attention to detail, regardless of the experience or status of the crewmember.

Adapted from NTSB-AAR-82-4

Quick Stoppers

AIRSPEED PLEASE

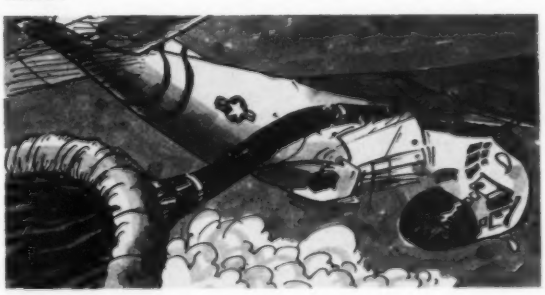
During a routine flight at FL 410, the crew of a C-21 noted their true airspeed, displayed on the Universal Navigation System, was 40 knots slower than that shown on the airspeed and Mach indicators. Looking a little closer, the crew also discovered fuel flow and RPM were lower than normal for flight. The aircraft commander decided to abort the mission and executed an uneventful landing using extra airspeed and the angle of attack indicator.

The maintenance team investigating the discrepancy discovered a seven knot indicated airspeed error at approach speeds and a 20 knot error at high altitude/high speed flight. The culprit was negative pressure induced in the pitot system during a routine 75-hour inspection. The negative pressure caused both pilots' airspeed pointers to peg against the bottom stops. The aircraft flew three missions prior to the time this deficiency was written up. Premature stall warning indications on two of the three flights were attributed to gusting winds and turbulence .... We wonder.

GUILLOTINE GLITCHES

Just another fine Fall flight over foreign fields for this HC-130P crew, and all was "Ops Normal"—or was it? The crew began configuring for their aerial refueling mission by extending the right refueling hose. Things went well until the hose was extended about 30 feet, whereupon it stubbornly refused to budge. Try as they might (and they did), the crew could neither extend or retract the obstinate hose. This didn't bode well for the mission, so they reluctantly proceeded to a safe area to jettison the hose IAW the checklist—the effort failed. They then decided (smartly) to take the ailing Herk home. They performed a controllability check with 100% flaps and made several attempts to jettison the hose by changing airspeed and turning, but, alas, to no avail. The crew decided to land with the hose extended, and maneuvered to final carefully, avoiding populated areas as best possible. After all their effort and care, five miles from the runway, at 2,000 feet, the hose self-jettisoned. Fortunately, it landed in a sparsely populated area and no injuries resulted.

The maintenance professionals took a close look and discovered the guillotine switch was activated, but the blade failed to cut completely through the hose. The hose, it seems, is wire-reinforced (as it must be), and the blade just couldn't slice all the way through. The investigators recommended an improved blade, just to make sure the hose will be cut all the way through, the first time.



Quick Stoppers

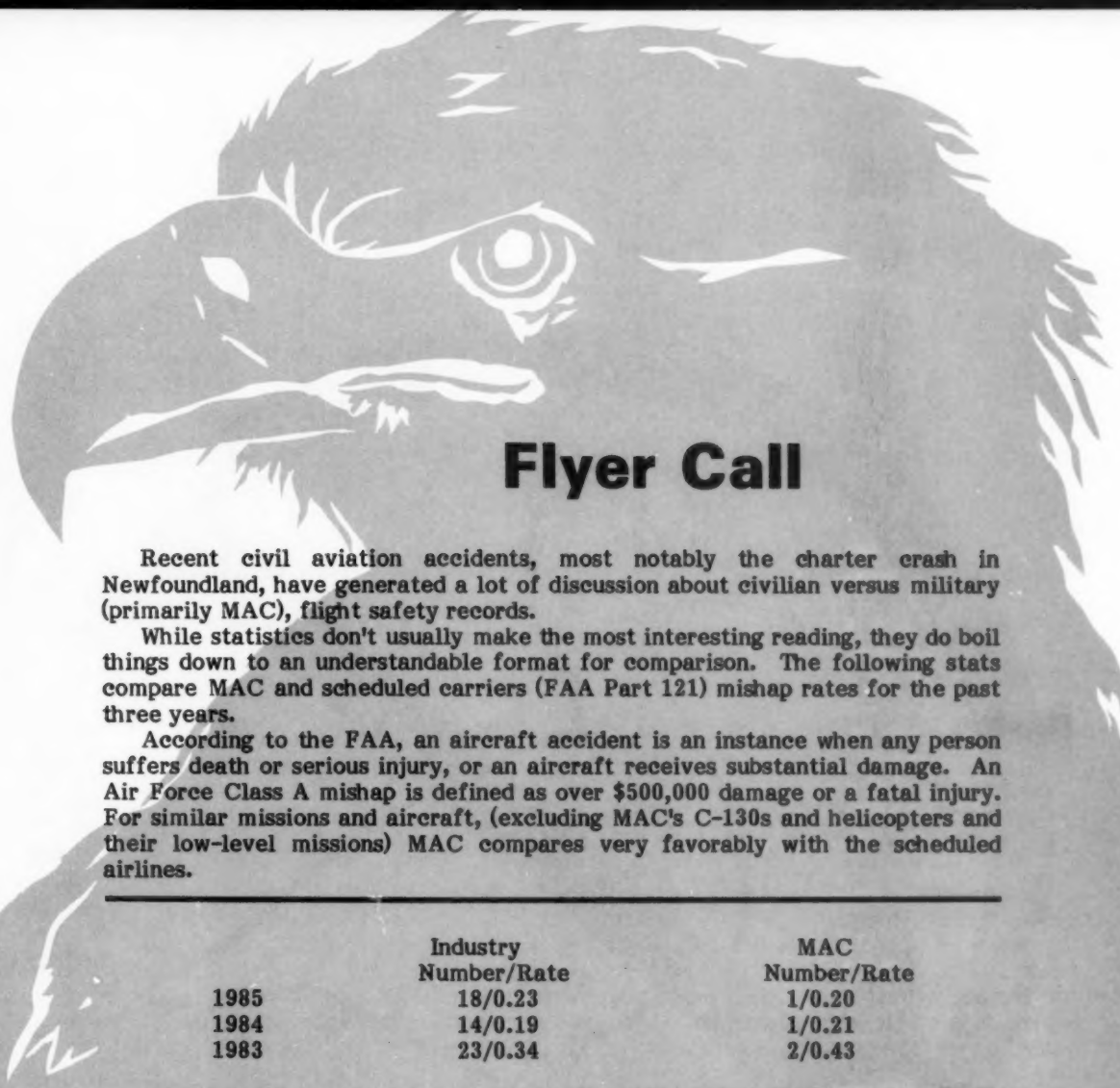
NO S-OAP

The relentless rotor wing rovers were cruising VFR in VMC at 500 ft AGL, when the master caution and engine chip segment lights of the UH-1H illuminated. Respecting the consequences of a number-one engine failure in a single engine aircraft, the crew wisely opted to accomplish a precautionary landing to check out the source of the illuminated lights. A home-drome maintenance team and FCF pilot flew out to the remote landing site to size up the situation. They took engine OAP (Oil Analysis Program) samples and visually checked the chip detector. The OAPs were flown back to base for analysis while inspection of the chip plug revealed only a small amount of metal "fuzz." Suspecting a momentary electrical malfunction, the FCF pilot ran the Huey in an attempt to duplicate the malfunction. The 45 minute ground-run showed all systems were operating normally and no caution lights illuminated. Confident the lights came on due to errant electrons, the FCF pilot boldly launched his craft back towards the barn.

Five minutes into the flight, the master caution and chip detector lights lit up again. The FCF pilot decided that the helipad at a nearby missile launch facility was a good place to wait this one out and landed uneventfully. Again, maintenance responded, and again the chip detector plug revealed only the smallest traces of metal particles. However, this time the aircraft was secured for an RON pending the results of the OAP tests due the next morning.

The following day, results of the OAP tests revealed no unusually high metal content in the oil. The perplexed maintenance team ran the aircraft once more, this time with new oil, and took four more OAP samples. Post engine-run inspection of the chip detector once more produced small metal particles. Exasperated, they said "enough is enough," called in a flatbed, and trucked the humbled Huey home.

Of the four OAP samples taken that day, only one (from the accessory gear box) finally revealed high chromium content. Maintenance wisely decided to change the engine.



Flyer Call

Recent civil aviation accidents, most notably the charter crash in Newfoundland, have generated a lot of discussion about civilian versus military (primarily MAC), flight safety records.

While statistics don't usually make the most interesting reading, they do boil things down to an understandable format for comparison. The following stats compare MAC and scheduled carriers (FAA Part 121) mishap rates for the past three years.

According to the FAA, an aircraft accident is an instance when any person suffers death or serious injury, or an aircraft receives substantial damage. An Air Force Class A mishap is defined as over $500,000 damage or a fatal injury. For similar missions and aircraft, (excluding MAC's C-130s and helicopters and their low-level missions) MAC compares very favorably with the scheduled airlines.

	Industry Number/Rate	MAC Number/Rate
1985	18/0.23	1/0.20
1984	14/0.19	1/0.21
1983	23/0.34	2/0.43

Looking a little deeper, MAC may compare even more favorably considering flight crew and maintenance personnel experience, equipment age, and the diversity and austerity of locations where MAC operates.

MAC's "You Call, We Haul," philosophy also places unique demands on crewmembers not ordinarily experienced by their civil aviation counterparts.

These cold numbers reflect the professionalism, pride, and desire of everyone in MAC to do the job right. We at *The MAC Flyer* hope to print even better statistics next year.

Another statistic that tells the MAC safety story is the new record established 24 Feb 86 when MAC passed its 300th day without a Class A mishap. The old record set in 1983 was 299 days, but we had seven Class B ($100,000-$500,000) mishaps during that period. There have been only three Class B ($100,000-$500,000) mishaps since the last Class A mishap on 30 April 1985. It's easy to become complacent when things are going well. Don't let your guard down. Let's strive to make it a full mishap-free year.

TCW

☆ US GOVERNMENT PRINTING OFFICE: 1986 564-018/20012

Beware—The Birds Are Back!